REMARKS

Status of Claims

Claims 1-22 are pending in the application. Claims 1-22 have been rejected under 35 U.S.C. §102(b) as being anticipated by Temple et al. (1993 IEEE.)

Objection to the Specification

Page 2 has been amended to change "result" to "results" and claim 1 has been amended to provide antecedent basis for "the first region."

35 U.S.C. §102(b) Rejection

Reconsideration is requested of the rejection of claims 1-22 under 35 U.S.C. §102(b) as being anticipated by Temple et al. (1983 IEEE).

Claim 1 is directed to a single crystal silicon segment having, among other things, a non-uniform distribution of minority carrier recombination centers with the concentration of the centers in the bulk layer being greater than the concentration in the surface layer and with the centers having a concentration profile in which the peak density of the centers is at or near the central plane with the concentration generally decreasing from the position of peak density in the direction of the front surface of the segment.

In contrast, as illustrated in Fig. 1A and Fig. 1B, Temple et al. suggested the desirability of having a region of enhanced recombination (i.e., short minority carrier lifetime) within the device in a plane which is perpendicular to the direction of the on-state current flow. Temple et al., however, then state that the basic structure of such a device

> is not easily achievable experimentally. **Any practical applications would involve an extensive development program (which is currently underway at General Electric Co) with an unknown chance of success.** To discuss, in detail, possible methods for implementing the proposed structure is outside the scope of this paper.... Instead, we have utilized our exact computer modeling capabilities... to study forward drop and turn-off time in a p-i-n diode and a thyristor both with the normal doping and lifetime profile of Fig 5, and with the lifetime profile structured as in the previous section.[1]

---

[1]Temple et al., at page 784, emphasis added.

Any doubt that Temple et al. had not, as of the date of the publication of their paper, prepared such a device is eliminated by the introduction to their paper:

> We describe the **proposed structures** and comment on the results of our feasibility study which, to date, is based primarily on exact **computer modeling**. Preliminary studies are underway.[2]

It is well established that in order to be anticipatory, a reference must enable a person of ordinary skill to make and use the claimed invention. In this instance, not only do Temple et al. fail to report the preparation of such a device, they do not disclose any means to prepare one and affirmatively cast doubt upon whether it could ever be done. Accordingly, Temple et al. do not anticipate the invention defined by claim 1.

Furthermore, Temple et al. discuss semiconductor devices generally. In contrast, claim 1 is specifically directed to a single crystal **silicon** segment. While silicon is a semiconductor, there are others. Thus, the recitation of semiconductor is not an anticipation of silicon.

Claims 2 and 3 specify the carbon concentration of the silicon segment of claim 1. The Office has noted that Temple et al. do not disclose intentional carbon doping. The absence of intentional doping, however, would not invariably lead to the preparation of semiconductor material having less than the specified amounts of carbon. The burden is upon the Office to establish a prima facie case of anticipation and this burden has not been carried.

Claims 4 and 5 specify a minimum thickness for the segment. Since Temple et al. did not prepare any sample, it necessarily follows that these claims could not be anticipated: they do not describe the preparation of any segment of any thickness.

Incredibly, the Office has not even attempted to establish a prima facie case of anticipation with respect to the remainder of the claims. The Office has not because it cannot.

Claims 6 and 7 specify a maximum concentration of minority carrier recombination centers. Nowhere do Temple et al. disclose any corresponding structure.

Claims 8-11 specify the thickness of the surface layer which, as required by claim 1, has a concentration of minority carrier recombination centers which is less than the concentration of the minority carrier recombination centers in the bulk layer. Temple et al. fail to disclose such a structure.

---

[2]Temple et al., at page 782, emphasis added.

Claim 12 specifies that the front surface of segment is polished; Temple et al. fail to disclose a polished segment.

Claim 13 is directed to a single crystal silicon segment having, among other things, a non-uniform distribution of minority carrier recombination centers with the concentration of the centers in the bulk layer being greater than the concentration in the surface layer and with the centers having a concentration profile in which the peak density of the centers is between the central plane and the front surface layer with the concentration generally decreasing from the position of peak density in the directions of the front surface and the central plane of the segment.

The Office has not even attempted to articulate a prima facie case of anticipation of claim 13 based upon Temple et al. The Office has not because it cannot; Temple et al. fail to disclose any such structure.

Claims 14 -22 depend from claim 13, but specify requirements discussed above in connection with claims 2-12. Again, the Office has failed to articulate a prima facie case of anticipation with respect to these claims.

The Office's citation of several references in paragraph 6 of the Office action is noted. Since none of these references have been applied to the claims in support of any rejection, however, applicant need not comment upon the Office's characterization.

In view of the foregoing, favorable reconsideration and allowance of all claims is respectfully requested.

VERSION WITH MARKINGS SHOWING CHANGES MADE

IN THE SPECIFICATION:

The second paragraph on page 2, beginning at line 6 with:

It is known in the art that doping semiconductor devices with lifetime killing impurities (i.e., recombination centers such as gold or platinum) results in an increase in the recombination rate when the device is turned off, and thus an increase in the switching speed as well. (See, e.g., V. Temple and F. Holroyd, "Optimizing Carrier Lifetime Profile for Improved Trade-off Between Turn-off Time and Forward Drop," IEEE Transactions on Electron Devices, ed. 23, pp. 783-790 (1983).) In the past, such impurity doping has typically been applied to large areas of the device, even throughout the entire bulk of the device. This approach has resulted in significant decreases in the device turn-off time. However, accompanied with this improvement is an increase in device forward voltage drop. Similar results have been obtained when alternative methods of "lifetime killing" have been employed, including electron, proton and gamma radiation, throughout the bulk of the device.

IN THE CLAIMS:

Replace claim 1 with:

1. (amended) A single crystal silicon segment having two major, generally parallel surfaces, one of which is the front surface of the segment and the other of which is the back surface of the segment, a central plane between the front and back surfaces, a circumferential edge joining the front and back surfaces, a surface layer which comprises a **first** region of the segment below the front surface and a distance, D_1, as measured from the front surface and toward the central plane, and a bulk layer which comprises a second region of the segment between the central plane and the first region, the segment being characterized in that

the segment has a non-uniform distribution of minority carrier recombination centers, with the concentration of the centers in the bulk layer being greater than the

concentration in the surface layer and with the centers having a concentration profile in which the peak density of the centers is at or near the central plane with the concentration generally decreasing from the position of peak density in the direction of the front surface of the segment.

OIPE JC136
AUG 09 2001
PATENT & TRADEMARK OFFICE

RECEIVED
AUG 15 2001
TECHNOLOGY CENTER 2800

CONCLUSION

In view of the foregoing, applicant respectfully submits that claims 1-22, which are now pending in this application, satisfy the requirements for patentability. Favorable reconsideration and allowance of these claims are therefore respectfully requested.

A check for $110.00 is enclosed for a one month extension of time fee. The Commissioner is hereby authorized to charge any underpayment and credit any overpayment of government fees to Deposit Account No. 19-1345.

Respectfully submitted,

Edward J. Hejlek, Reg. No. 31,525
Senniger, Powers, Leavitt & Roedel
One Metropolitan Square, 16th Floor
St. Louis, Missouri 63102
(314) 231-5400

EJH/dep
*Enclosure